Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 1997**	2. REPORT TYPE	3. DATES COVERED **00-00-1997 to 00-00-1997**

4. TITLE AND SUBTITLE **Stochastic Modeling of Bottom Scattering in Shallow Water**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Washington,Applied Physics Laboratory,1013 N.E. 40th Street,Seattle,WA,98105**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**2**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

STOCHASTIC MODELING OF BOTTOM SCATTERING IN SHALLOW WATER

Darrell R. Jackson
Applied Physics Laboratory, College of Ocean and Fishery Sciences,
University of Washington, Seattle, Washington 98105
phone: (206) 543-1359 fax: (206) 543-6785 email: drj@apl.washington.edu
Award Number: N00014-96-1-0121
Category of Research: High-Frequency Acoustics

LONG-TERM GOALS

The objective of this research is to improve the accuracy and widen the regime of applicability of stochastic models for bottom acoustic scattering in shallow water.

SCIENTIFIC OBJECTIVES

The primary scientific objective is to develop scattering approximations leading to realistic stochastic models for acoustic scattering by the sea floor and for acoustic penetration into the seafloor.

APPROACH

This research employs perturbation theory, which is perhaps the most tractable means of dealing with realistic boundary scattering problems. The perturbation approach is capable of treating sediment stratification as well as elastic and poroelastic effects. In addition, perturbation theory provides a starting point for powerful "modern" methods such as the small-slope expansion. The resulting models are used in various ways: direct comparisons with backscattering strength data in experiments where sufficient physical data are available, modeling of scientific experiments (particularly acoustic penetration experiments), and transitions to practical sonar performance prediction models.

WORK COMPLETED

Work on simulation of sound penetration experiments has continued in collaboration with Thorsos and Williams. Closely related Monte-Carlo simulations in collaboration with Thorsos have been used to study near-field assumptions often employed in sea floor scattering work. In collaboration with Ivakin, a first-order pert urbation treatment of roughness and volume scatteringin elastic sea beds has been documented. A stochastic model for the spatial and temporal spectrum of sediment inhomogeneities has been developed by Christopher Jones and fitted to scattering data from the ONR Orcas experiment.

RESULTS

Our past simulations of acoustic penetration experiments showed that rough-surface scattering of the ordinary acoustic wave can mimic a slow Biot wave. Continued work on this topic has shown that the apparent attenuation yielded by this process is consistent with the experimental results of Chotiros. With regard to the far-field approximation used in these and other seafloor scattering calculations, theory supported by Monte Carlo simulations has been used to show that this approximation is valid at ranges set by the acoustic wavelength, much shorter than ordinarily supposed.

A forced diffusion model for the generation and evolution of sediment inhomogeneities has been developed and coupled with a perturbative scattering model. The overall model has been compared to data from the Orcas experiment to estimate biodiffusivity. Further work is needed to connect this model with more traditional measurements of biological reworking of soft sediments.

IMPACT / APPLICATION

These scattering models are employed in weapons and sonar simulations and are expected to become part of a future bottom scattering data base. The models are also intended for inversion to obtain seafloor physical properties in both scientific and survey applications. Work on penetration is expected to impact countermeasure techniques for buried mines.

TRANSITIONS

The results of research under this grant will be transitioned to practical seafloor scattering models at mid- and high-frequencies for use in sonar performance prediction. For example, past modeling work is now incorporated in a high-frequency bottom backscattering model that is included in the Oceanographic and Atmospheric Master Library, and the elastic scattering model developed with Ivakin has been incorporated into a next-generation bistatic scattering model under Torpedo Environments (6.2) sponsorship. Finally, previous versions of these models have found use in inversions for seafloor properties (e.g., the recent work of Turgut).

RELATED PROJECTS

This work is directly related to the ONR High-Frequency Acoustics Program and the ONR-NRL Coastal Benthic Boundary Layer (CBBL) Project. Close coordination is maintained with the ONR projects of Anatoliy Ivakin, Kevin Williams, Eric Thorsos, and Dajun Tang in problems of bottom scattering and penetration.The models developed here will be applied to scattering data obtained in the CBBL and STRATAFORM projects.